THE TIME IS NOW

Systemic Changes to Increase African Americans with Bachelor’s Degrees in Physics and Astronomy
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The AIP National Task Force to Elevate African American Representation in Undergraduate Physics & Astronomy (TEAM-UP)

American Institute of Physics
College Park, MD

www.aip.org

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This report is an Expert Report of the American Institute of Physics and was accepted as such by the AIP Board of Directors on November 13, 2019.
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Finally, and most importantly, we owe a debt of gratitude to the students who participated in the TEAM-UP study through surveys and interviews. We thank you for openly and honestly sharing some of your most heart wrenching stories with us, but also stories of determination and triumph, which give us hope. This report is meant to tell your stories, center your experiences, and inspire the physical science community to improve in ways that support your success in earning your physics and astronomy degrees.

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Foreword
Shirley Malcom, AAAS

In 2006 I was honored to have been invited to contribute an article to Physics Today. “Diversity in Physics” explored the continuing challenge within the physics community to attract women from all racial/ethnic groups and African American, American Indian, and Hispanic men to the field. That issue of the journal https://physicstoday.scitation.org/toc/pto/59/6 included a collection of articles that looked back at the world of physics in the 75 years since the founding of AIP and those that peeked over the horizon to what might lie ahead.

In the ensuing years since writing that article, many things have changed; but unfortunately, some things have not. In the period between 2006 and 2016, among U.S. citizens and permanent residents, African Americans received between 7 and 8 per cent of chemistry bachelor’s degrees, between 5 and 6 per cent of bachelor’s degrees in mathematics and statistics and between 9 and 12 per cent of such degrees in computer science. While most of these numbers are unacceptably low and not reflective of students’ presence within the college going population, the story for physics is particularly depressing.

The report from TEAM-UP points out that the stubborn challenges of under participation by African Americans within physics remain. For bachelor’s degrees in physics for African Americans, the needle has hardly moved since 2006.

Both the 2006 article and this report from the comprehensive TEAM-UP study point to the need for systemic change. The TEAM-UP report not only lays out the case for change, but also incorporates important research that points to the roles that the physics community needs to play at every level. It calls for actions at every level and for a specific timeline and targets.

The physics community has demonstrated its capacity time and time again to come together in addressing important societal issues, such as its active engagement within the Societies Consortium on Sexual Harassment in STEMM and its development of department level transformation initiatives within SEA Change to support diversity, equity and inclusion.

The TEAM-UP report points the way toward an aggressive and achievable path forward, a path that aligns with and supports the work of both the Societies Consortium and SEA Change. Drawing on important social science research as well as its own robust statistical and qualitative analyses, the report points to the need for a multi-pronged approach to support inclusion of African American men and women in physics. It should be reassuring that other research on the broader problem of marginalization and weeding out in STEM programs tracks with the findings and recommendations of the TEAM-UP report.
While predominantly white institutions (PWIs) now enroll most African American physics students, HBCUs still play an outsized role in terms of physics bachelor’s degree production. A number of policy questions arise from this finding. For example, can we make a case for higher levels of support for physics programs at HBCUs, with more partnerships and opportunities for undergraduate research? Should physics programs at PWIs be required, within funding proposals, to articulate diversity plans that speak to incorporation of policies, programs, practices, instructional strategies, etc. of demonstrated effectiveness in advancing education and degree completion by African Americans students? How do we support efforts to incorporate the knowledge, support and the will exhibited by historically and predominantly black institutions within physics programs at PWIs? What role might there be for national labs and federally funded centers to support career interests and funding for African American students?

The action plan outlined in the TEAM-UP report is a great place to start in building out a community-wide strategy.

The 2006 article included an observation supported by research that I raise again here, as I noted how very young children experience and learn about the physical world through play and social interaction.

“How do children move from behaving in ways that are so clearly consistent with learning about the physical world to avoiding courses that can support their understanding of it? Put a different way, how does physics move from being an inclusive domain for learning to an exclusive or exclusionary one?”

How do we take advantage of demonstrated interest to keep African American students in the talent pool for physics, to nurture their interest, to make them feel welcomed and accepted, to engage and support their learning? Those are the challenges and the opportunities for the physics community.

Shirley Malcom, PhD, is a senior advisor at the American Association for the Advancement of Science (AAAS) and director of STEM Equity Achievement (SEA) Change, an initiative that supports institutional transformation in diversity, equity, and inclusion. She has served as Head of Education and Human Resources Programs at AAAS for nearly 30 years, and is a trustee of Caltech, and Regent of Morgan State University. Malcom formerly served on the National Science Board and on President Clinton’s Committee of Advisors on Science and Technology. In 2003, she received the Public Welfare Medal of the U.S. National Academy of Sciences, the highest award given by the Academy. Malcom is a Fellow of AAAS and of the American Academy of Arts and Sciences, and serves on the boards of the Heinz Endowments, Public Agenda, NMSI and Digital Promise.

Malcom holds BS and MA degrees in zoology from the University of Washington and UCLA, respectively, and earned her PhD in ecology from Penn State.
Reader’s Guide to the Report

This report is unusual in many ways for the physical sciences. First, it was researched and written by a team of physicists, astronomers, and social scientists, collectively called TEAM-UP. Second, while it presents data and draws conclusions, as a research publication does, it is also full of quotes from students. It discusses at length concepts like belongingness and change management, which may seem far removed from physics and astronomy research to some. In fact they are not removed from these subjects, because who does research depends on who belongs, and on whether change occurs to diversify the disciplines. TEAM-UP members firmly believe that scientists cannot solve the problem of African American underrepresentation using methods common to physics and astronomy; new thinking and new language are needed. Consequently, this report is unlike any strategic plan a physicist or astronomer is likely to produce for their field; it emphasizes changing how we think, rather than changing processes and outcomes. In other words, this report aims to shift the cultures of the physics and astronomy communities in order to improve outcomes for African American students.

The report is organized as follows. The Executive Summary, which follows this guide, presents the thematic structure that emerged from our research and summarizes findings centered on the experience of African American students. The findings lead to a set of recommendations for individual faculty, departments, and professional societies. The full findings and recommendations are summarized in the last chapter, followed by a Glossary introducing and defining many terms used in the report that may be unfamiliar to some readers. Readers may skim the Glossary to determine their readiness for the main chapters.

The main research findings and recommendations are presented in the chapter Supporting Student Success. Organized by the five factors highlighted in the Executive Summary, this chapter presents the research case and describes many effective practices observed in TEAM-UP site visits. The findings are drawn from TEAM-UP and extant research; each finding leads to a recommendation. Additional recommendations are made as a result of the interactions among individuals, departments, colleges and universities, and professional societies.

The student chapter is followed by A Call to Action, which places the problem addressed by this report, the underrepresentation of African Americans in undergraduate physics and astronomy, in a broader societal context. This chapter also discusses the need for a highly developed understanding of institutional change and provides relevant recommendations. Finally, it presents a bold vision for how the physics and astronomy communities might inspire others to emulate their efforts. In many ways, this chapter is the most important one of the report. TEAM-UP determined that methods and results from the social sciences
are essential to solving the problems of underrepresentation in physics. This concluding chapter is a fast-paced introduction that should be followed by further study and sensemaking.

A set of appendices provides detailed background on our methodology as mentioned in the Introduction. Additionally, three appendices were created specially to help students and departments: Appendix 8 is a self-assessment rubric for departments, Appendix 9 is a rubric for high school students and their parents to evaluate prospective physics and astronomy departments, and Appendix 10 is a resource guide for students, faculty, and others working to advance racial equity in the physics and astronomy professions.

The goal of this report is to motivate the key stakeholders within and outside the physics and astronomy communities to work together to systematically increase the number of African American students earning bachelor’s degrees in physics and astronomy, and to inform and guide them in this effort. Although this report was written for and researched about the physics and astronomy disciplines, the relevant research literature spans all the STEM (Science, Technology, Engineering, and Math) fields, and the report may be useful in guiding research and practice in these fields too.

TEAM-UP invites the physics and astronomy communities to read this report carefully, acknowledge that there is room for improvement within their programs to support African American students, and consider how they might begin to implement the recommendations found herein. Most of the recommendations are already being followed in several of the top-performing departments we visited.
Executive Summary

During 2018 and 2019, TEAM-UP, the National Task Force to Elevate African American representation in Undergraduate Physics & Astronomy, examined the reasons for the persistent underrepresentation of African Americans in physics and astronomy in the US as measured by bachelor’s degrees in these fields. The task force was chartered by the Board of Directors of the American Institute of Physics and charged with producing a detailed report and recommendations.

To determine the key factors supporting or diminishing student success, TEAM-UP conducted a major research study that included student surveys, department chair surveys, interviews with African American students, and site visits to five high-performing physics departments. In addition to these data collection efforts, the task force reviewed the research literature and received input from several hundred individuals to guide the work. This report combines original research with a review of the research literature to provide a set of research-based findings and recommendations.

TEAM-UP identified five factors responsible for the success or failure of African American students in physics and astronomy: Belonging, Physics Identity, Academic Support, Personal Support, and Leadership and Structures. In the body of the report, each factor is supported by four research findings and four corresponding recommendations for individual faculty, departments, and/or professional societies. A fifth recommendation is made for each major factor to address the interactions among individuals, departments, colleges and universities, and professional societies. The recommendations are far-reaching and challenging, requiring philosophical and practical changes in the way the community educates and supports students. To support the adoption of the recommendations, the report provides an additional set of five recommendations on Change Management. Together, the five factors and the topic of Change Management provide six themes around which this report is organized.
The task force finds that African American students have the same drive, motivation, intellect, and capability to obtain physics and astronomy degrees as students of other races and ethnicities. Many African Americans who might otherwise pursue these fields are choosing majors that are perceived as being more supportive and/or rewarding, resulting in a loss of talent to physics and astronomy.

The briefest summary of the TEAM-UP report is this: the persistent underrepresentation of African Americans in physics and astronomy is due to (1) the lack of a supportive environment for these students in many departments, and (2) to the enormous financial challenges facing them and the programs that have consistently demonstrated the best practices in supporting their success. Solving these problems requires addressing systemic and cultural issues, and creating a large-scale change management framework.

The overarching goal of this report is to at least double the number of bachelor’s degrees in physics and astronomy awarded to African Americans by 2030. This report calls on departments and professional societies, working with funding agencies, foundations, and donors, to commit to achieving this goal. Every recommendation in this report is a means to this end.

Below is a summary of the task force’s key findings and recommendations, organized by the five factors responsible for the success or failure of African American students in physics and astronomy and the sixth topic of change management. It starts with factors that are the most centered on the individual student and ends with those reflecting the broadest academic context. The highest priority recommendations are identified at the end of the Executive Summary. The full set of key findings and recommendations is given in the last chapter.

FACTOR 1: BELONGING

| Fostering a sense of belonging is essential for African American student persistence and success. |

A sense of belonging is defined as an individual’s feeling of being a welcomed and contributing member of a community. TEAM-UP’s research on the student experience shows that fostering a sense of belonging is essential for African American student persistence and success. Faculty and peer interactions have a powerful effect on students’ sense of belonging, which increases with the number of faculty who get to know students as individuals and demonstrate support for their success. Student peers play a role in mitigating or exacerbating African American students’ sense of not belonging, through microaggressions, the imposter phenomenon, and stereotype threat. Peers of the same race/ethnicity/gender provide valuable social and academic supports, often through counterspaces.

The recommendations around belonging emphasize the faculty role in fostering a sense of belonging for students but also note the essential roles that departments and professional societies play. In summary, TEAM-UP recommends that departments support faculty in improving and practicing skills that promote students’ sense of belonging. Departments should establish and consistently communicate norms and values of respect and inclusion through policies, physical spaces, programmatic offerings, and all forms of communication with students. Professional societies should pursue coalition-building efforts that seek to address and eliminate identity-based harassment including microaggressions and acts motivated by bias and racism.

1 These and other technical terms are defined in the Glossary.
FACTOR 2: PHYSICS IDENTITY

To persist, African American students must perceive themselves, and be perceived by others, as future physicists and astronomers.

Physics identity is defined as how one sees oneself with respect to physics as a profession. It evolves with one’s perception and navigation of experiences within physics, including recognition by others. How students perceive themselves with respect to physics is predictive of career intentions and achievement. Here too, faculty play an important role in helping shape physics identity among African American students, who have already had to contend with and overcome stereotypes about who is interested in or capable of becoming a physicist or astronomer. TEAM-UP found that faculty encouragement, recognition, and representation are key enablers of physics identity. Physics identity is strengthened in African American students when they have same-race role models in the faculty, are routinely invited and financially supported to participate in the established activities of the profession, and are able to connect their physics education to activities that benefit their communities.

The TEAM-UP recommendations provide departments with the means to create a strong sense of physics identity in their students. Departments should take a strategic approach to building physics identity in students by determining whether current activities foster physics identity, assessing their efficacy across race/ethnicity/gender and other social identities, and using evidence-based strategies to modify those activities as necessary. Departments should also work to diversify their faculty across race/ethnicity/gender and other social identities. Departments and faculty should utilize resources, such as the AIP Careers Toolbox and African American alumni, to discuss a broad range of career options with undergraduates and communicate the ways in which physics and astronomy degrees empower graduates to improve society and benefit their community.

FACTOR 3: ACADEMIC SUPPORT

Effective teaching and a strengths-based approach to academic support are necessary for African American student retention and success.

Academic support is perhaps the first topic many physics faculty think of when considering how to address the underrepresentation of African American students, since providing such support is traditionally regarded as the responsibility of those who educate students. Indeed, effective teaching, mentoring, and student-centered support are important for retention and success of African American students, as they are for all students. However, it is a damaging myth that minoritized students—members of underrepresented groups who are marginalized in society—have, as a consequence of their identity, learning challenges or needs, and that if they work harder to bridge those gaps, they will achieve greater success. This sentiment, whether intentional or not, is played out every day on virtually every level, from interactions with peers to those with faculty and beyond. TEAM-UP site visits and the research literature show that recognizing student capabilities and building

2 Astronomy identity development is important, too, but unlike physics identity, it has not yet become a commonly used term in the education research literature.
on their strengths lead to better outcomes than focusing on their presumed weaknesses. Further, faculty who
teach well, care about students, and demonstrate commitment to them by affirming their academic abilities,
encouraging their success, and helping them find additional academic resources when needed, are critically
important in fostering student success. Advising systems contribute to retention by providing early warning of
student difficulties and allowing timely intervention. Providing multiple pathways into and through the major
helps to recruit and retain African American students.

TEAM-UP’s recommendations for academic support strengthen the services that departments are expected
to provide to students—teaching, mentoring, and advising—with a focus on African American student
success. Departments should encourage and support new faculty in improving teaching and mentoring by
attending campus workshops or those provided by professional societies and other organizations. They
should also adopt policies and practices that encourage faculty, including those who are not members of
marginalized groups, to formally and informally mentor students, and should provide recognition and rewards
for these efforts. Faculty and staff undergraduate advisers should work closely with campus advising offices
to provide cohesive support and comprehensive resources for students facing academic or other difficulties,
and departments should ensure that all students are aware of support services. Finally, departments should
regularly assess their activities and curricular pathways from recruitment through degree attainment, identify
points at which students leave or stop out before graduation, and develop evidence-based action plans to
increase student persistence.
FACTOR 4: PERSONAL SUPPORT  Many African American students need support to offset financial burdens and stress.

Colleges and universities provide students with many kinds of support in addition to academic support. African American students often face challenges that require assistance from non-faculty experts, and awareness and referral by faculty can improve students’ utilization of these resources. TEAM-UP research identified financial challenges as one of the greatest difficulties facing African American students. These financial stressors, much like a lack of academic support, can lead to increased need for mental health care and a greater risk of students leaving the major or school. Student retention improves when faculty recognize and respond to students as unique individuals with a wide range of intersecting social identities and acknowledge that their experiences of being minoritized in physics and astronomy departments may impact their academic performance. Access to jobs related to their major, such as paid research internships, help ease financial burdens and allow students to earn needed income while supporting their academic progress and reinforcing their physics identity.

Several of TEAM-UP’s recommendations on personal support for students help faculty and departments navigate what may be unfamiliar or difficult territory. Faculty should seek funding for undergraduate students to work in research groups, and as Learning Assistants, for example, to help students advance academically while earning money. Similarly, departments should be aware of emergency and auxiliary financial aid and help students take advantage of these resources. Faculty should normalize seeking help for mental health needs by discussing self-care with students and pointing them to resources, and they should recognize the unique identity and promise of each student from a perspective of students’ strengths rather than weaknesses.

The final recommendation within this category seeks to minimize the financial burden for African American physics and astronomy students in a larger way. A consortium of physical science societies should be formed to raise a $50M endowment to support minoritized students in physics and astronomy who have unmet financial needs. Half of the endowment income would go to direct support of African American physics and astronomy students and half would go to support departments’ implementation of this report’s recommendations and to support other financially marginalized groups in the future. As an interim step, physics and astronomy societies should raise $1.2M per year to relieve the debt burden of African American bachelor’s degree students. The latter figure corresponds to the typical unmet need of $8K/year for 150 students, which is the number of additional African American students who should be earning physics bachelor’s degrees at HBCUs (Historically Black Colleges and Universities) in order to achieve parity with the growth in physics degrees at Predominantly White Institutions since 1995.
FACTOR 5: LEADERSHIP AND STRUCTURES

For sustainability, academic and disciplinary leaders must prioritize creating environments, policies, and structures that maximize African American student success.

Effective departments create and sustain a supportive environment for their students. Department chairs play a key role in setting and acting on departmental priorities. Whether a department adopts the goal of increasing the number of bachelor’s degrees awarded to African American students, and what steps it takes to support that goal, are functions of the leadership. Effective academic leadership utilizes committees, existing decision-making bodies, internal funding and other resources, and coalition building with campus programs and external organizations to effect change. Sometimes a singularly dedicated faculty member, or a lone champion, creates a supportive environment for African American students. However, evidence shows that the efforts of a lone champion are unsustainable. By contrast, in the most successful departments, a significant fraction of the faculty consistently value and support African American students as part of the department’s culture and established practice.

In keeping with the findings, TEAM-UP’s recommendations on Leadership and Structures advocate that department chairs set departmental norms and values of inclusion and belonging and that they actively partner with campus programs that provide scaffolding to support student belonging, STEM identity development, and personal and academic support of African American students. As well, department administrators should support and encourage students to utilize these important resources. Department chairs should also incentivize and reward multiple faculty members, including those who do not identify as faculty of color, to actively support underrepresented students. Professional societies should encourage relevant groups within their organizations to examine ways to advance the recommendations of this and similar reports.

CHANGE MANAGEMENT

A new level of thinking is required to solve a persistent problem.

The underrepresentation of African Americans in physics and astronomy is a systemic problem that cannot be solved through the isolated work of individual faculty, departments, or professional societies. It requires coordinating the efforts of stakeholders acting at all of these levels. In addition, standard approaches of strategic planning are unlikely to succeed because the underlying norms, values, and culture of the profession need to be addressed before lasting changes can occur. Fortunately, there is a growing body of literature on successful culture change in higher education to inform this work. This literature posits that preparatory work must be done prior to modifying processes toward a stated goal. First, a theory of change must be developed to guide the change process. Effective change management considers the broader context for change and creates a shared understanding among key stakeholders of the need for and approach to creating the change.

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3 A theory of change is a comprehensive description and illustration of how and why a desired change is expected to happen in a particular context
Professional societies have a leading role to play in this effort, as they did in the early 2000s with the SPIN-UP project, which succeeded in its goal to increase overall physics bachelor’s degree production. Professional societies and individual departments should each develop a theory of change around doubling the number of African Americans earning bachelor’s degrees in physics and astronomy, utilizing sensemaking and shared leadership. Representatives from all groups should jointly produce a unified change management model highlighting the interactions among the societies, universities, departments, and individual physicists and astronomers needed to support these efforts. Professional societies should facilitate these activities by holding discussion forums on this topic; empowering and preparing change agents through skill-building activities; and establishing recognition, rewards, and other incentives for efforts by faculty members to improve the success of African American students in physics and astronomy.

Finally, it is TEAM-UP’s intention that this report not sit on a shelf but be used to inform, inspire, and serve as a guide toward real and lasting change. The last chapter of the report provides several means to encourage progress, including by recognizing the social responsibility of physicists and astronomers, and by providing assessment rubrics for high school students, parents, and faculty members, to evaluate departmental environments for African American students. Departments should review and learn from this report and the related reports and programs of other professional societies that address different aspects of diversity, equity, and inclusion. Professional societies and individual departments should gather relevant data about their organizations, disaggregated as appropriate by race/ethnicity/gender, and address disparities. All appropriate groups should begin to implement the recommendations found in this report, and an organizational body, to be determined, should assess and publicly communicate progress toward the recommendations of this report every two to four years, including quantitative and qualitative data similar to those used herein.

Priorities

We cannot emphasize enough the systemic nature of the problem under discussion: the persistent underrepresentation of African Americans in physics and astronomy is due to the lack of a supportive environment for African American students in many departments, and to the enormous financial challenges facing these students in general. Solving these problems requires changing not only the way physicists train students, but how they think about training students. The challenges are too difficult to be solved by individuals or even departments alone; physics and astronomy overall must be engaged through their professional societies. The solution requires both will and money.

Perhaps the first thing individual physicists and astronomers should do is consider their role in establishing their departmental cultures and commit to creating an environment where African American students and those from other marginalized communities can thrive. Consequently, this report’s highest-priority recommendation is to read and discuss this and related reports (Recommendation 6b under Change Management). Professional societies, working with departmental representatives, should utilize sensemaking and shared leadership to develop theories of change for individual departments and professional societies and should also establish faculty networks, learning communities, and skill-building workshops (Recommendations 6a and 6c under Change Management). The APS Inclusion, Diversity, and Equity Alliance (APS-IDEA, Appendix 10) provides a framework for these efforts.

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4 Indeed, SPIN-UP helped double the number of physics bachelor’s degrees in just over a decade, thus demonstrating that a community-wide, goal-driven change effort can succeed.

5 Theory of change, sensemaking, and shared leadership each have a specific meaning in research on higher education. See the Glossary.
For professional societies, the first step is to support these change management processes and encourage existing and new groups within their organizations, such as the new APS Forum on Diversity and Inclusion, to examine ways to advance the recommendations of this and similar reports (Recommendation 5e). The second step is to raise substantial funding to support minoritized students with unmet financial need in physics and astronomy, and to support the implementation of this report’s recommendations by departments (Recommendation 4e).

For department chairs, the highest priority is to identify campus and external resources that provide financial relief to students and help students with unmet needs take advantage of them (Recommendation 4a). Next is to begin the hard work of culture change by setting norms and values of inclusion and belonging; recruiting, developing, and supporting a diverse faculty; and overseeing structures, policies, and practices that enhance the success of African American students (Recommendation 5a).

After physicists and astronomers have understood the nature of the problem, they can begin to undertake actions addressing the five factors in student success (Belonging, Physics Identity, Academic Support, Personal Support, and Leadership and Structures). For individual faculty, the top priority should be to learn, practice, and improve skills that foster student belonging in their interactions with undergraduates (Recommendation 1a). The next priority for individual faculty is to seek funding for undergraduate students to work in research groups, as Learning Assistants (defined in the Glossary), or find other ways to help students advance academically while earning money (Recommendation 4b).

After undertaking these steps, individual researchers, department chairs and officers, and professional societies will be able to identify the next steps appropriate to their context from among the many other recommendations in this report.